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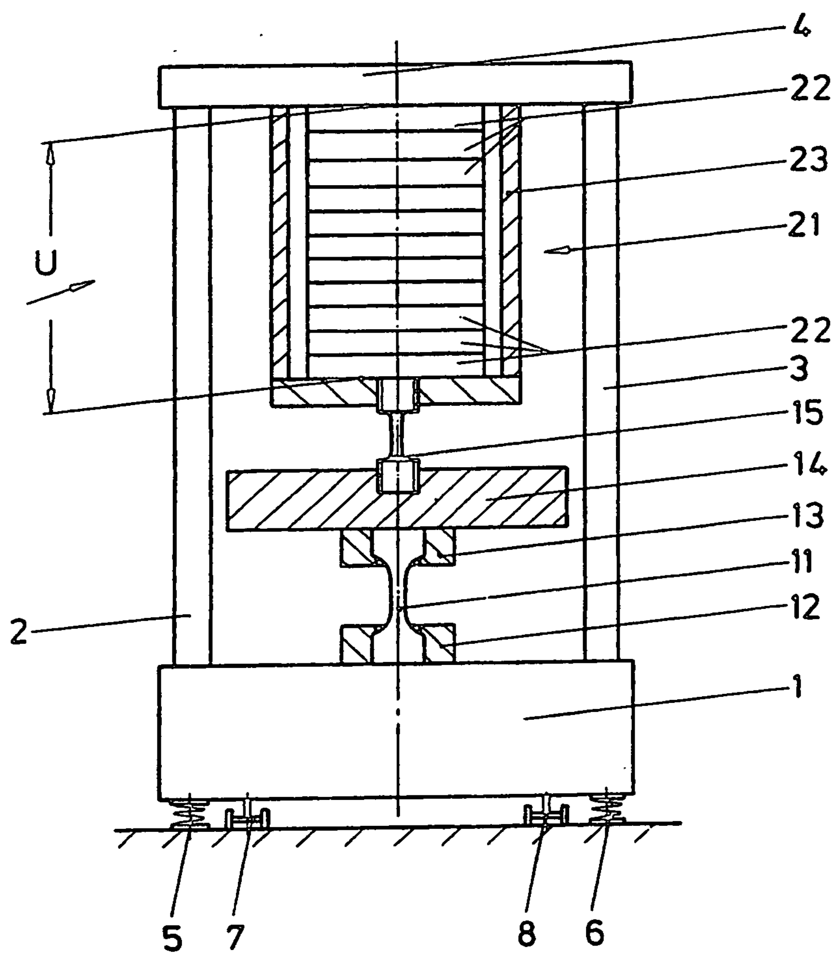
(54) A materials testing machine

(57) The machine has a frame 1—4 for receiving the object to be tested 11 and a device 21 for applying load to the object to be tested; the loading device is constituted by piezo-electric elements 22 which when excited electrically, generate the loading forces. This arrangement permits high frequency testing which may be controlled simply with a high degree of accuracy. Such an arrangement is also particularly advantageous for resonance testing machines for producing excitation forces.



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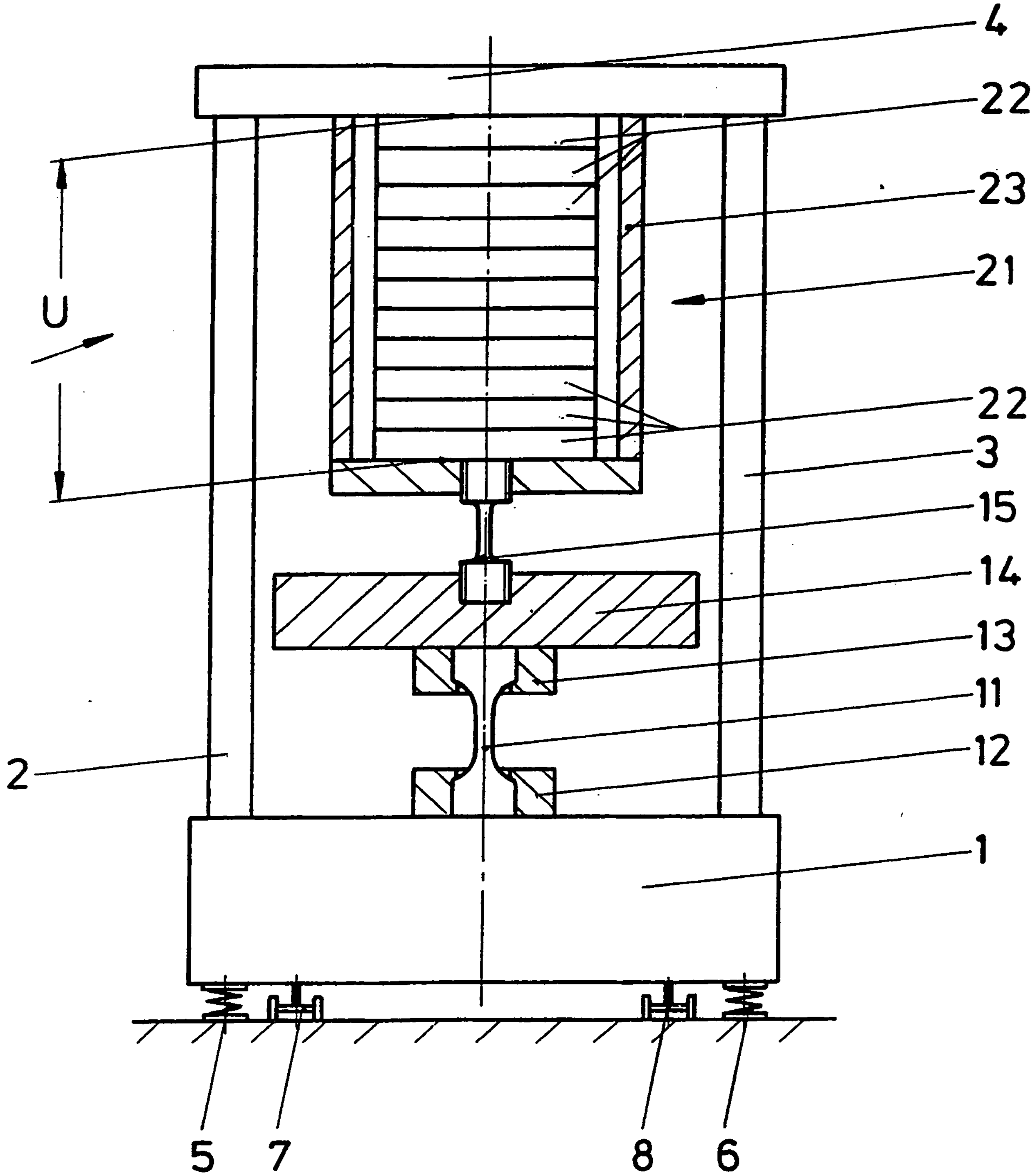
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SPECIFICATION

A materials testing machine having a piezo-el ctric driv

The invention relates to a materials testing machine having a testing frame and housing for the object to be tested as well as a device for putting the object to be tested under load.

It is known to use mechanical, electrodynamic and hydraulic drives in material testing machines. All of these known drives are limited in their frequency to a range of a few hundred Hz.

It is an object of the present invention to provide a drive for a material testing machine, more particularly for a testing machine operated in resonance, at low cost in terms of construction. It is another object of the present invention to provide a drive which permits high testing frequencies up to the kilohertz range and makes it possible to control the frequency simply, to a high degree of accuracy while retaining the predetermined desired values for the loads and/or path of travel.

According to the present invention there is provided a materials testing machine with a testing frame means for accommodating an object to be tested and a device for loading the object to be tested wherein the loading device comprises a piezo-electric member which when subjected to electrical control, generates forces in the direction of loading. In arrangements according to the invention piezo-electric elements are used in suitable form and arrangement as an actuating device, i.e. for producing testing or exciter forces for testing machines.

The piezo-electric effect is known in technology. If certain crystals are deformed by mechanical loading then electrical charges are generated on them. Conversely, the same materials change their dimensions under the action of electrical charges and may therefore exert high loads. Crystals or piezo-electric elements in which these phenomena occur are for example quartz crystals or synthetically produced ceramic elements such as metal oxides.

A preferred embodiment of the present invention will now be described with reference to the accompanying drawing which shows a resonance testing machine with a piezo-electric drive.

The testing machine has a counter mass 1, a testing frame 2, 3 arranged on the counter mass and a transverse yoke 4. The counter mass 1 is supported on the base by means of resilient elements 5, 6 and, if necessary, dampers or shock absorbers 7, 8.

An object under test 11 is fixed to the counter mass 1 by means of a gripping device 12. Th other end of the object under test is connected to a resonant mass 14 by means of a further gripping device 13. The resonant mass 14 is connected to a loading or energizing device 21 by means of an adjustable resonant spring 15 which is shown in the form of a rod in the drawings.

The resonant spring 15 serves to initiate excitation in the resonant system formed largely by the specim n 11 and the resonant mass 14 as well as by the resonant spring 15 itself and if necessary by other elements of the testing device.

By using a resonant spring the resonant system may be excited or energized particularly advantageously and economically since, if the spring is designed appropriately, only small excitation paths of travel are necessary (spring excitation). This excitation may be introduced directly into the resonance system without any intermediate resonant springs (mass excitation). Furthermore it is possible to prestress the resonant spring 15, in a manner not shown, either by tension or compression and thus to apply an additional prestress (mean load) to the specimen 11 during resonance operation.

In order to duplicate or simulate predetermined desired values, loading functions or loading cycles when testing materials and components by the so-called servo-controlled mode or load simulation mode of operation the loading or energizing device 21 may be directly connected to the specimen 11 by means of suitable connecting elements or gripping devices, i.e. without the interposition of a resonant mass or a resonant spring.

The energizer device 21 has a number of successive piezo-electric elements 22. The piezo-electric elements may be formed as discs or plates and stacked one on top of the other, e.g. to form a rod-shaped member. They are separated from each other by means of intermediate layers of a suitable material with each slice having its own electrical connection. The electrical connections are not shown in the drawing for the sake of simplicity.

The number, size, construction and arrangement of the piezo-electric elements are selected so that the desired loads and/or paths of travel may be set at the testing machine. Several stacks of piezo-electric elements may also be arranged symmetrically of the loading axis of the testing machine in a manner not shown.

Since the piezo-electric elements can generally accommodate large compression forces but only small tension forces they are prestressed by a resilient frame 23 against the transverse yoke 4, i.e. they are prestressed by compression. The stressing may be undertaken by means of expansion screws or other suitable resilient elements. The said stressing is made so resilient that it only accommodates a small part of the loads produced by the piezo-electric elements during electrical controls.

As a result of suitable electrical control (voltage U) of the piezo-electric elements 22, they change their dimension in the direction of loading, i.e. in the example of embodiment shown in th vertical axis of the testing machine and produce the loads required for the testing operation. In the case of resonance operation the excitation frequency for the piezo-electric elements 22 is selected so that it corresponds to the natural frequency of the resonant spring-mass system of the object to be tested 11, th resonant mass 14, the resonant

spring 15 and the testing frame 1 to 4. Consequently, large mass forces which have to be absorbed by the specimen 11 may be produced with small energizer forces. Since the system is only very slightly damped, resonance increases of over 100 are achieved i.e. the loads or forces produced in the testing device are a factor of 100 greater than the energizer loads or forces.

In the load simulation operation objects under test may be tested at the desired loadings, forces, acceleration, etc. up to frequencies of a few kilohertz. The fact that the system is only slightly damped also provides a favourable energy balance. The loadings, therefore, may be set particularly accurately. The use of piezo-electric drive elements is particularly advantageous in resonance testing machines since these machines only require low exciter paths of travel if suitable exciter arrangements are provided. With testing machines in accordance with the present invention loads, accelerations, paths of travel and speeds may be applied to objects and components under materials testing. A frequency range up to a few kilohertz is provided at a particularly high degree of accuracy in accordance with the prescribed desired values and in fact this is the case both with resonance operation and also the servo-controlled mode or load simulation mode of operation.

CLAIMS

1. A materials testing machine with a testing frame, means for accommodating an object to be tested and a device for loading the object to be tested wherein the loading device comprises a piezo-electric member which when subjected to electrical control, generates forces in the direction of loading.

2. A materials testing machine according to Claim 1, wherein the piezo-electric member comprises stacked individual elements.

3. A materials testing machine according to Claim 1, wherein the piezo-electric member comprises several sets of individual elements which are arranged symmetrically of the axis of loading of the testing machine.

4. A materials testing machine according to Claim 1, 2, or 3, for carrying out resonance testing, wherein a resonant mass is arranged between the piezo-electric member and the object to be tested.

5. A materials testing machine according to Claim 4, wherein a resonant spring is arranged between the piezo-electric member and the resonant mass.

6. A materials testing machine according to Claim 5, wherein the resonant spring is a settable pre-stressing spring.

7. A materials testing machine according to any one of the preceding Claims wherein the piezo-electric member is prestressed by pressure in the direction of loading.

8. A materials testing machine substantially as herein described with reference to the accompanying drawings.

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